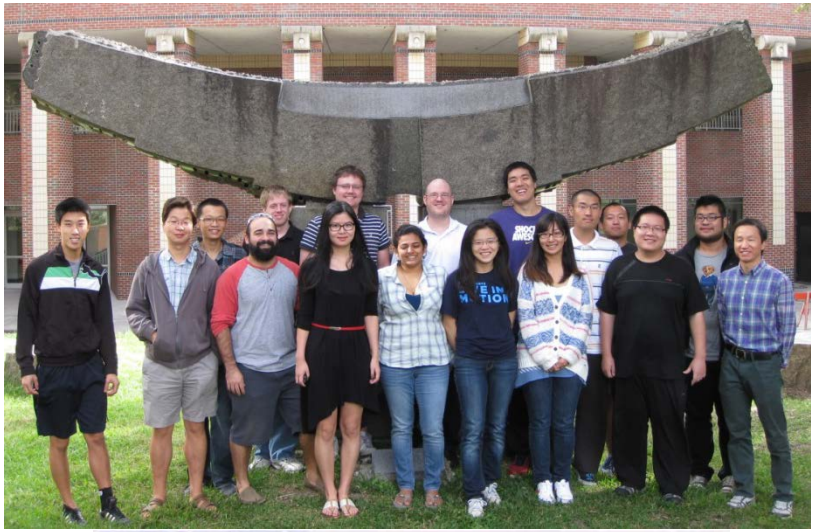

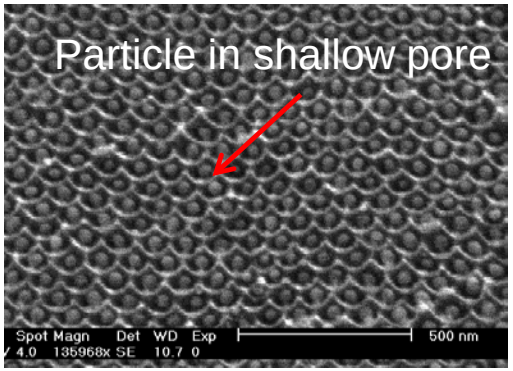

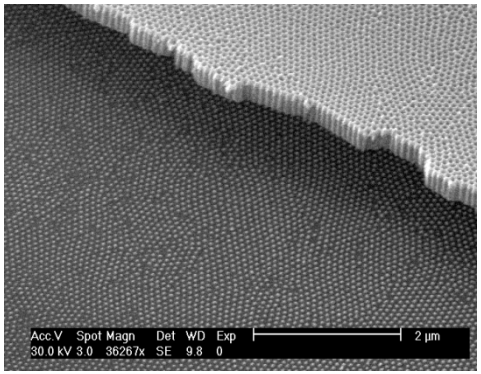

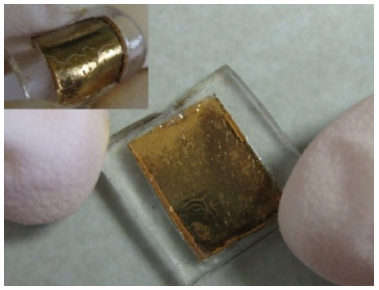

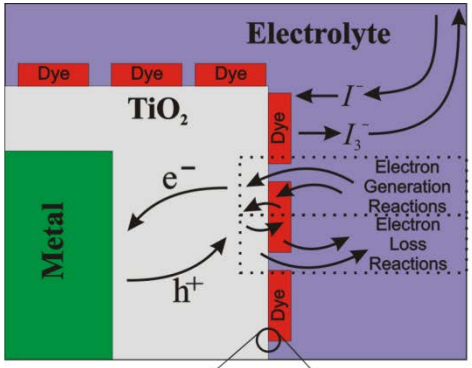

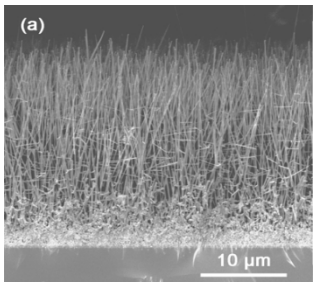

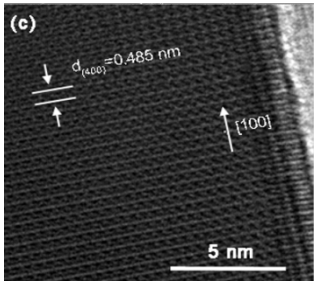

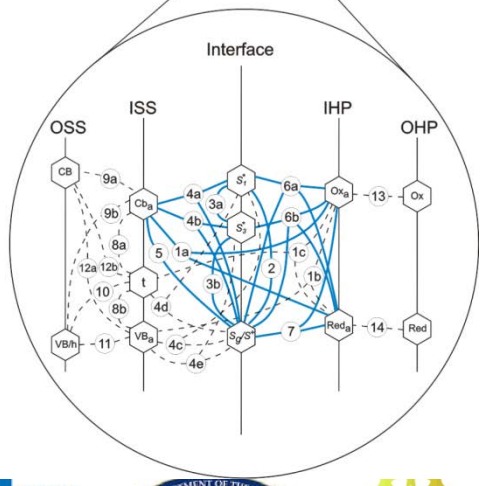

Nanoscale interfaces in energy applications

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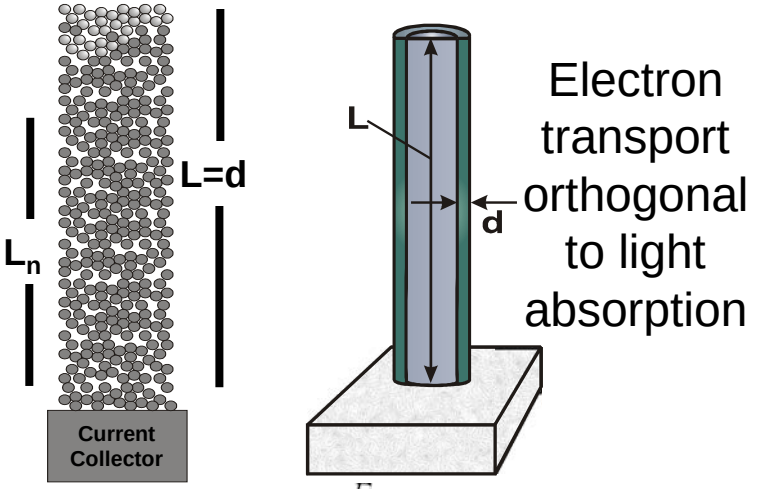
Chemical Engineering

ACS PRF

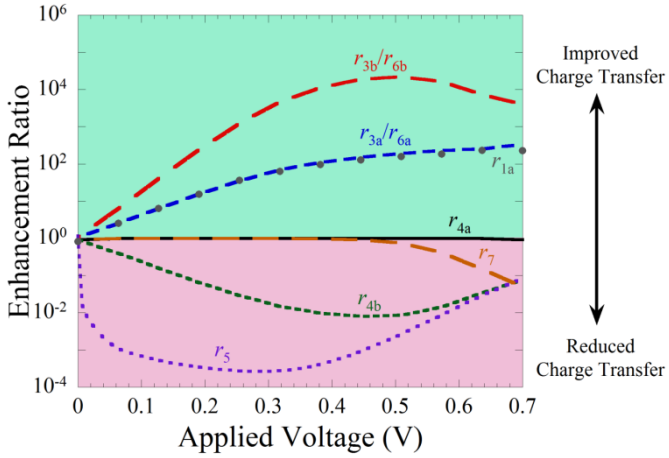
NSF

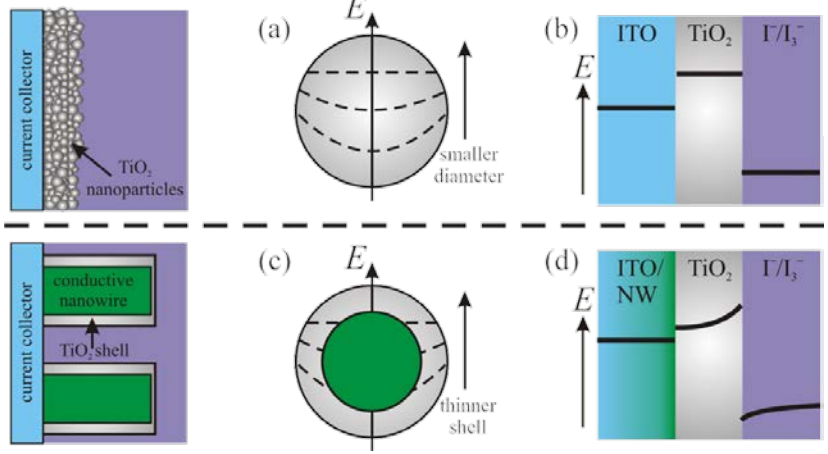
Nanowire-based dye-sensitized solar cells (DSSCs)

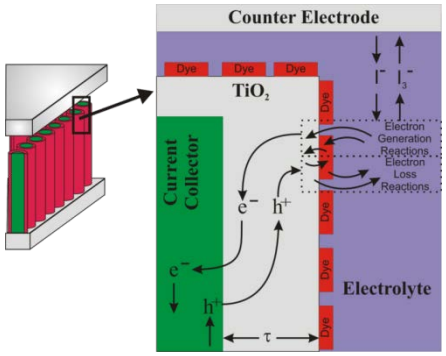


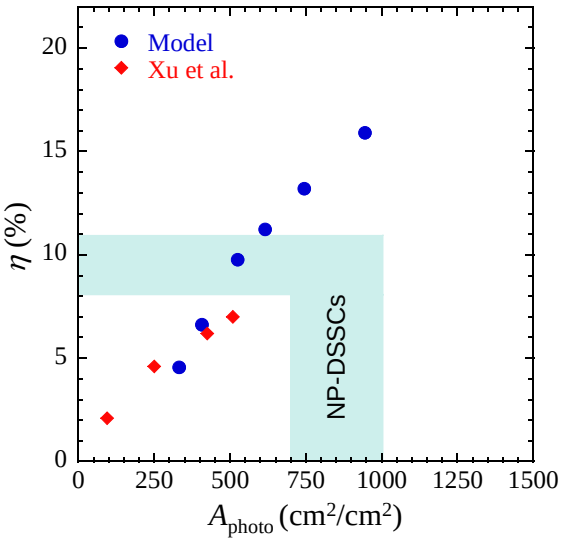
Electron transport orthogonal to light absorption

#	Reaction
(1a)	$\mathcal{A}\ \mathrm{Red} + nh^+ \underset{k_{b,1a}}{\overset{k_{f,1a}}{\rightleftharpoons}} \mathcal{B}\ \mathrm{Ox} + ne^-$
(2)	$S_g + h\nu \longrightarrow S_1^*$
(3a)	$S_1^* \xrightarrow{k_{3a}} S_3^*$
(3b)	$S_3^* \xrightarrow{k_{3b}} S_g$
(4a)	$S_1^* + h^+ \xrightarrow{k_{4a}} S^+ + e^-$
(4b)	$S_3^* + h^+ \xrightarrow{k_{4b}} S^+ + e^-$
(5)	$S^+ + e^- \xrightarrow{k_{5b}} h^+ + S_g$
(6a)	$\mathcal{B}\ \mathrm{Ox} + nS_1^* \xrightarrow{k_{b,6a}} nS^+ + \mathcal{A}\ \mathrm{Red}$
(6b)	$\mathcal{B}\ \mathrm{Ox} + nS_3^* \xrightarrow{k_{b,6b}} nS^+ + \mathcal{A}\ \mathrm{Red}$
(7)	$\mathcal{A}\ \mathrm{Red} + nS^+ \xrightarrow{k_{f,7}} \mathcal{B}\ \mathrm{Ox} + nS_g$









- Better physics
- Lower surface area

- Calculations demonstrate potentially higher efficiencies
- Unique ability to ‘tune’ some reactions

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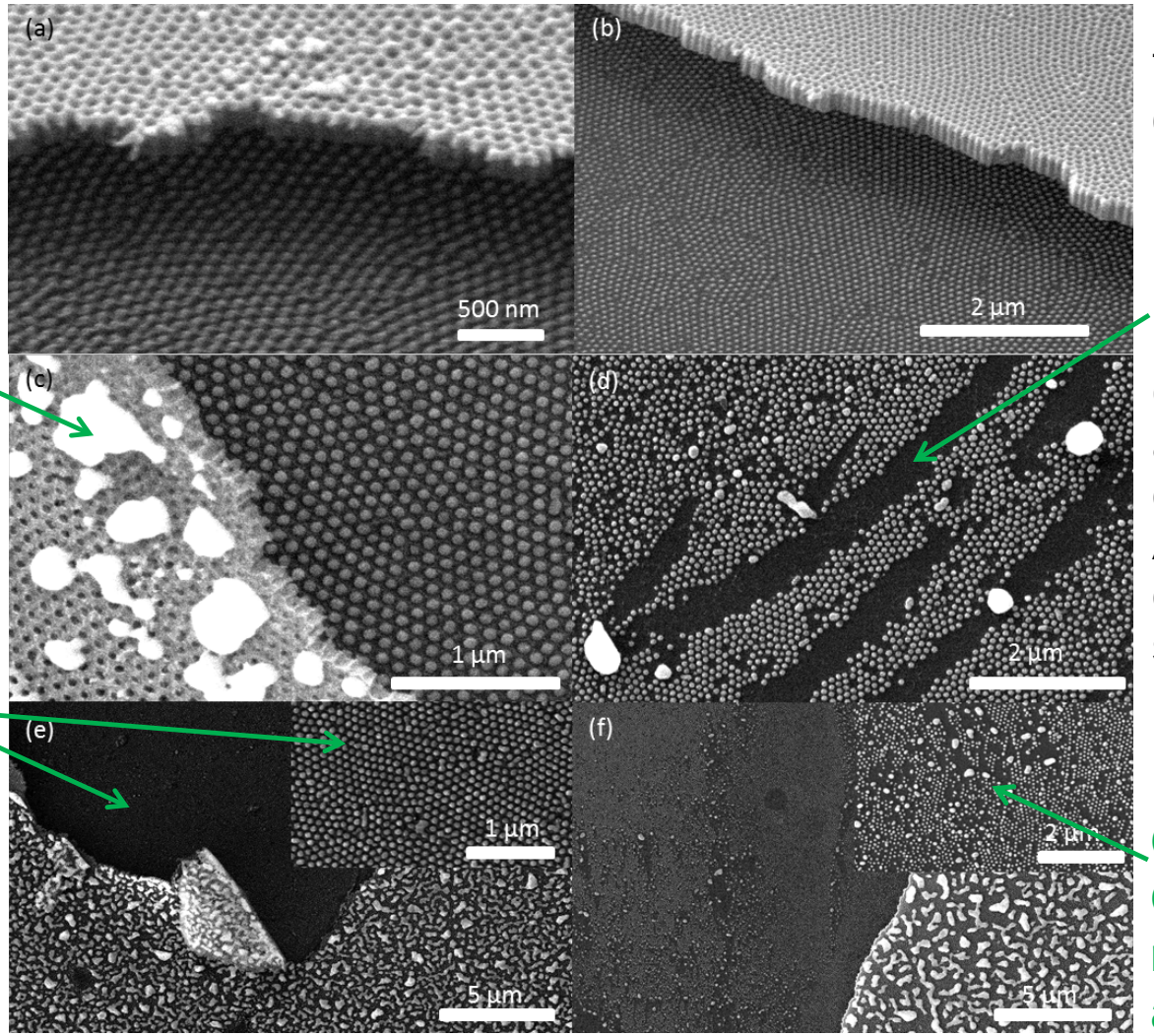
Thermally-stable nanoparticle arrays

NPs in Si nanocavities NPs on normal Si surface

No annealing



Template used to generate both nanoparticle arrays

Widespread agglomeration

Agglomeration only on template

Ostwald ripening and agglomeration observed on top of AAO template and on normal Si surface

Annealed at 600 °C for 3 h

High-res image of nanocavity shows almost no change

Annealed at 600 °C for 11 h

Continued Ostwald ripening and agglomeration

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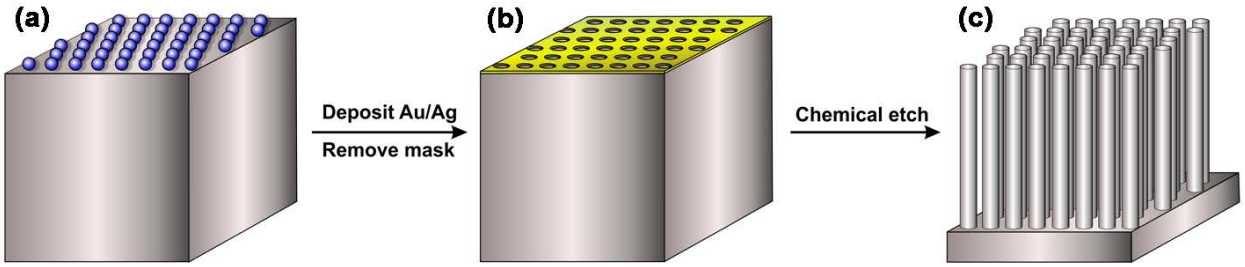
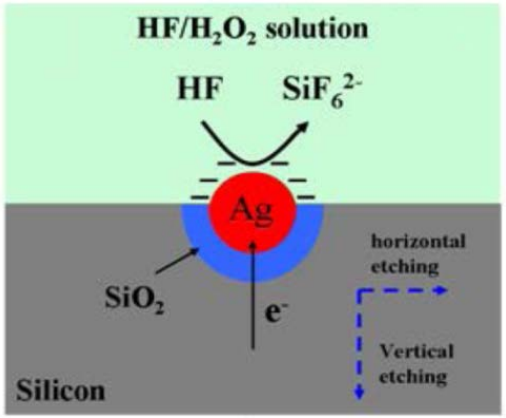
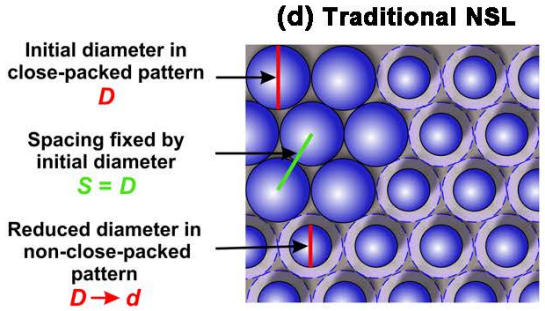
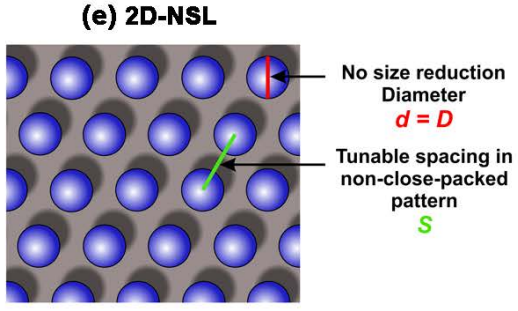
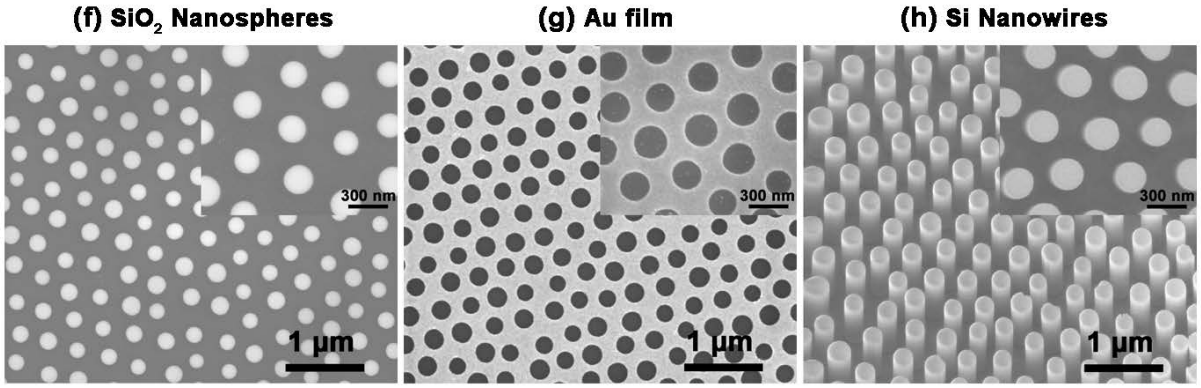
Controlled fabrication of Si nanowire arrays

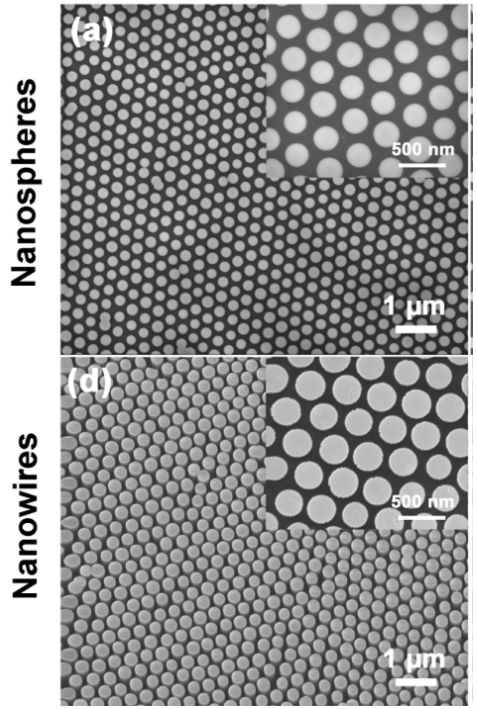












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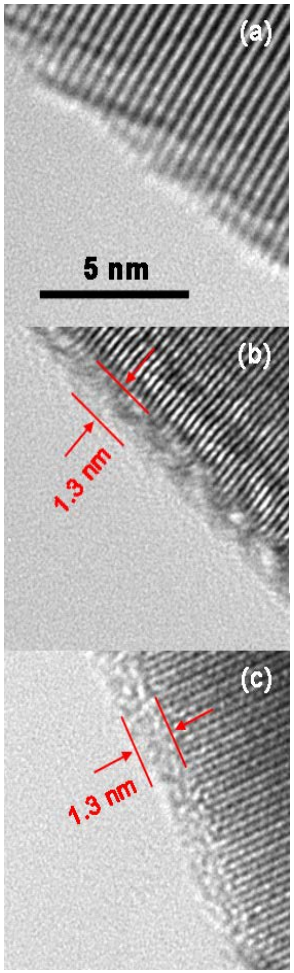
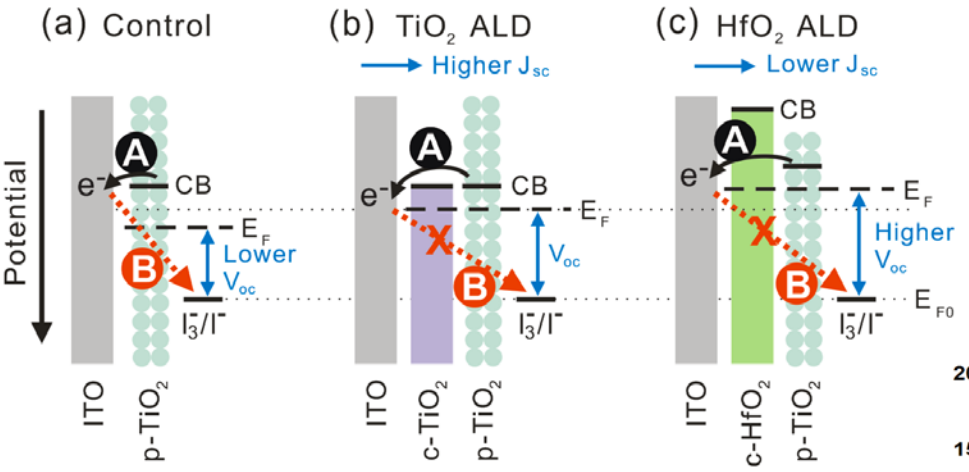
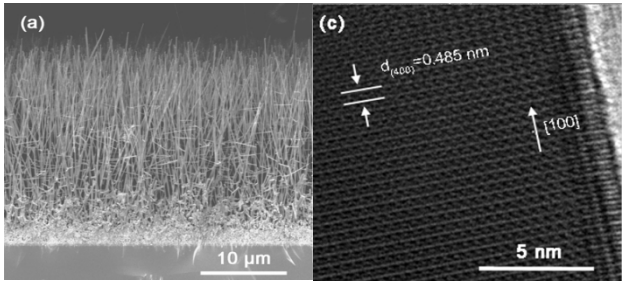
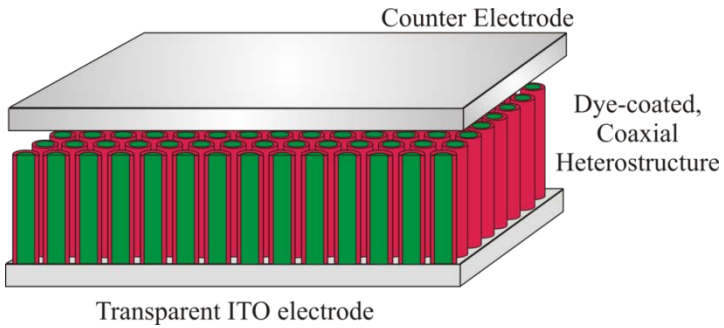
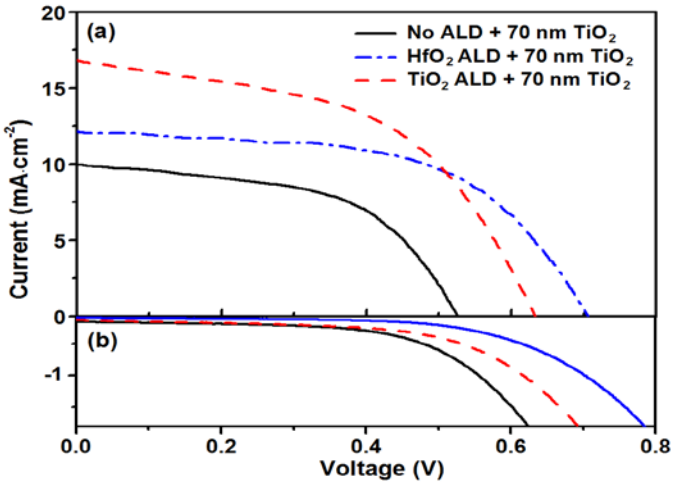
NW-based DSSC performance











	V_{oc} (V)	J_{sc} (mA·cm^{-2})	FF (%)	η (%)	Dye loading (x10^{-8} mol·cm^{-2})
Control	0.52±0.03	9.96±0.07	54.2±0.9	2.82±0.08	1.51
HfO_2 ALD	0.71±0.03	12.17±0.06	55.8±0.6	4.83±0.09	1.61
TiO_2 ALD	0.63±0.04	16.80±0.05	50.7±0.7	5.38±0.05	1.57

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